A Compact Bathyphotometer

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LONG-TERM GOALS

To develop, test, and deploy a compact and low cost Bioluminescence (BL) measuring Bathyphotometer. This real time system will lend itself to ship mounted, towed, and underway over the side measurements. The economy and simple application of this instrument will allow investigators who are not familiar with bioluminescence to perform fundamental BL field measurements.

OBJECTIVES

Bioluminescence in the ocean has been measured with low spatial resolution in both the horizontal and the vertical. A useful measurement however is determining bioluminescent activity for the purposes of identifying fronts. A small economical solid state sensor will allow investigators to add BL measurements to their experiments. All circuitry designed must be low power and small enough to be used as part of an expendable system.

APPROACH

The technical approach addresses the requirements to develop a low power solid state sensor with a compact housing and provide communications for moderate length cables (2 Km) and expendable wire systems. Previous designs have relied on Photomultiplier Tubes (PMT) as the optical sensing element. Their cost, size, and requirement for a high voltage supply for the most part prohibit them from being used in an expendable. A photodiode however while not as

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sensitive as a PMT can detect a wide range of bioluminescent activity. By using a microcontroller, the photodiode output can be sampled at a relatively high rate and converted to a digital data stream. The light levels can be integrated in the digital domain to yield a wide dynamic range. The expected spatial resolution for this instrument moving at 4 meters per second is below a meter.

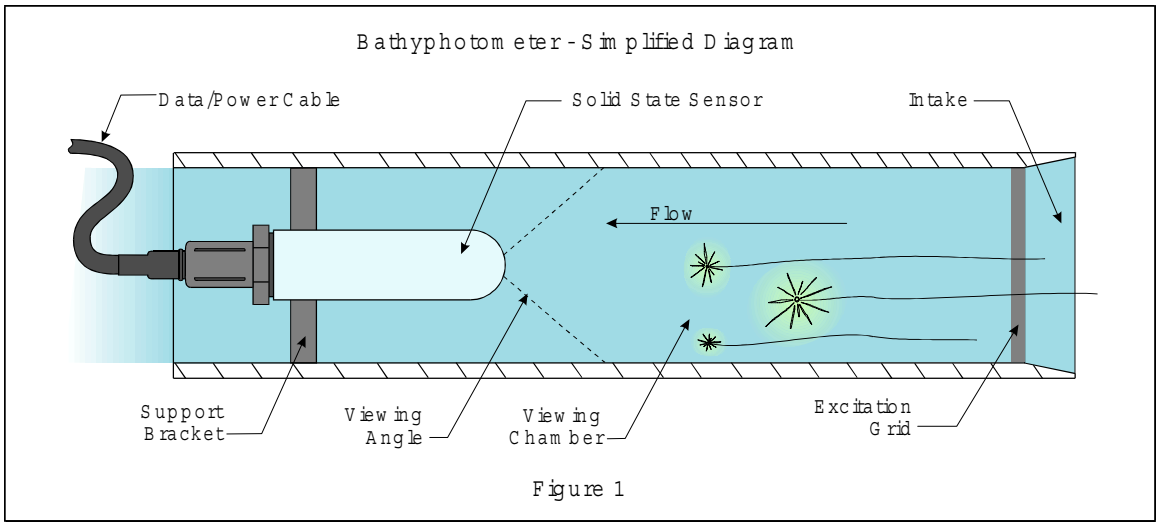

Figure 1

A simplified drawing of the Compact Bathyphotometer (CBP) is shown in Figure 1. This design employs a simple cylindrical chamber to view BL activity. The vehicle or free fall motion flushes the chamber and organisms striking the excitation grid emit light. A solid state sensor measures the light and sends the data to an acquisition system. Chamber diameters as small as 10 cm have been used and chamber lengths are typically 30 cm with the overall instrument measuring 50 cm long. We are developing a microcontroller based instrument that measures two channels of light, pressure, and temperature. The power supply and communications drivers all mount on the same surface mount technology board. A coin type battery powers the circuit.

WORK COMPLETED

In FY 99 the CBP has been deployed twice as a prototype. Printed circuit boards and an improved enclosure have been developed. Optical calibration procedures and tow tank tests have been identified. Improvements have been made to the hardware and software to extend low end sensitivity. In water hardware tests with the communication circuit over expendable wire have been successful. Test cruises have been identified with related hydrography including conductivity, temperature, chlorophyll, PAR, and turbidity measurements.

RESULTS

This instrument has been deployed on the undulating towed vehicle Seasoar as part of the East Sea Project. Continuous measurements were made for 12 days. An example of data is shown in Figure 2. The bioluminescence shown is in a relative scale, however a level of 800 is perceptible to a dark adapted human eye. The bioluminescence tracked the chlorophyll signal extremely well.

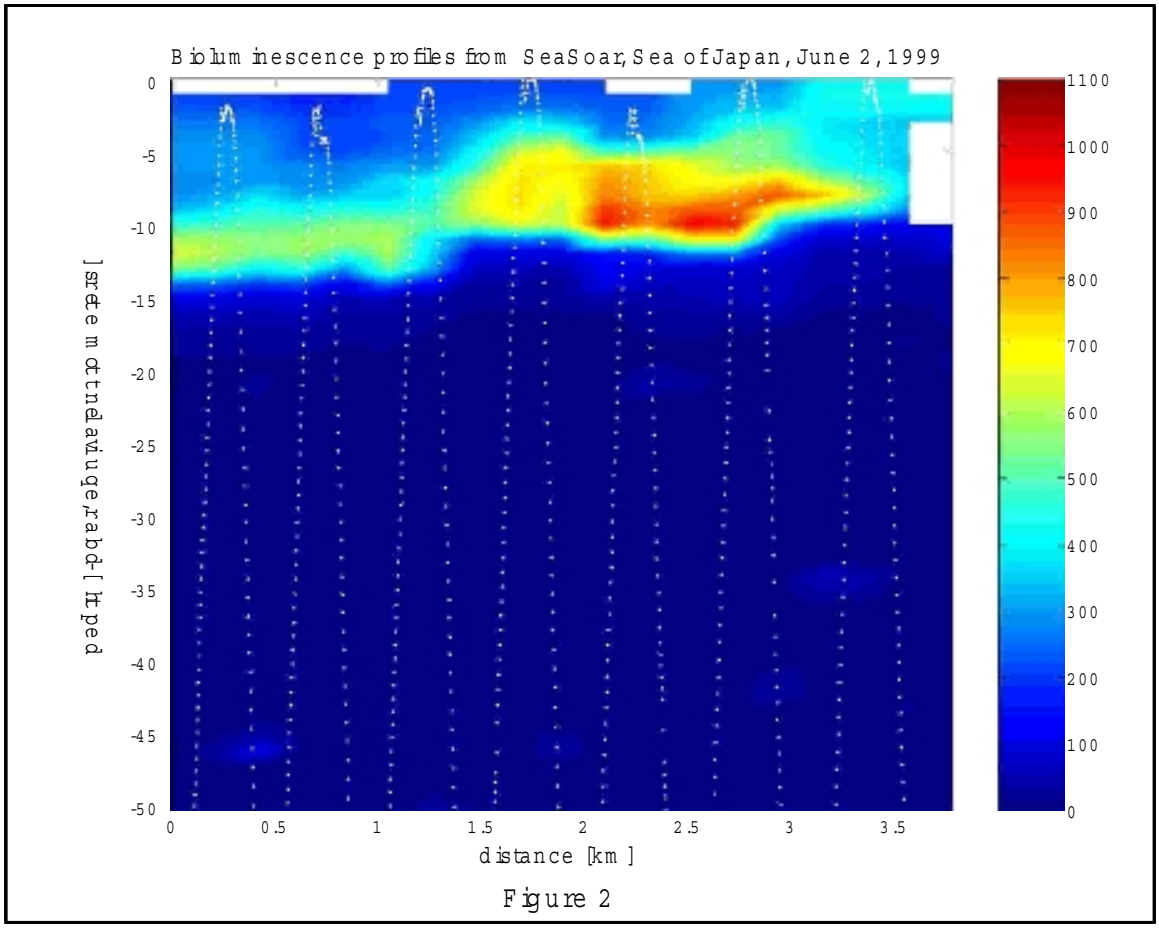

Figure 2

The dotted lines show the path of the Seasoar. Ship speed is nominally 8 kts. This was the first use of the all digital instrument with an integrated pressure sensor. A recording real time graphical display program was also developed.

IMPACT/APPLICATIONS

The potential for making a Bathyphotometer an out of the box instrument for both hard mounted underway and over the side (expendable) measurements will improve the world wide data base.

TRANSITIONS

This instrument will be made readily available to NAVOCEANO and other naval investigators for cross calibration with more sophisticated systems (for example, HIDEX).

RELATED PROJECTS

The digital expendable aspect of this instrument is lending itself to other expendable probes. While the development of this project has focused only on BL measurements, it would not be

difficult to reconfigure this sensor for 2 channel light extinction measurements. The microcontroller core is easily programmed to support other sampling algorithms and data output structures.

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